CLAIMS

What is claimed is:

1. A gas compressor, said compressor comprising:

(a) an inlet for supply of gas to be compressed;

(b) a rotor, said rotor having a central axis and adapted for rotary motion thereabout, said rotor extending radially outward from said central axis to an outer surface portion having an outer extremity;

(c) one or more supersonic shock compression ramps, each one of said supersonic shock compression ramps forming a features on said outer surface portion of said rotor;

(d) a stationary peripheral wall, said stationary peripheral wall

(i) positioned radially outward from said central axis, and

(ii) positioned very slightly radially outward from said outer extremity of said rotor; and

(iii) having an interior surface portion;

(e) said one or more supersonic shock compression ramps and said stationary peripheral wall cooperating to compress said gas therebetween;

(f) one or more strakes, each of said one or more strakes provided adjacent to one of said or more supersonic compression ramps, and at least a portion of each of said one or more strakes extending outward from at least a portion of said outer surface portion of said rotor to a point adjacent said interior surface portion of said peripheral wall;

(g) whereby said one or more strakes effectively separate said inlet gas from compressed gas downstream of each one of said supersonic gas compression ramps.

2. The apparatus as set forth in claim 1, wherein each of said one or more strakes comprises a helical structure extending substantially radially from said outer surface portion of said rotor.

3. The apparatus as set forth in claim 2, wherein the number of said one or more helical strakes is N, and the number of said one or more supersonic gas compression ramps is X, and wherein N and X are equal.

4. The apparatus as set forth in claim 1 or in claim 2, wherein each of said one or more gas compression ramps comprises a outwardly sloping gas compression ramp face, said face having a base, said base located adjacent the intersection of said outwardly sloping face and said outer surface portion of said rotor.

5. The apparatus as set forth in claim 1, or claim 2, or claim 4, wherein each of said one or more gas compression ramps further comprise one or more boundary layer bleed ports.

6. The apparatus as set forth in claim 5, wherein at least one of said one or more boundary bleed ports is located at said base of said gas compression ramps.

7. The apparatus as set forth in claim 5, wherein at least one of said one or more boundary bleed ports is located on said face of said gas compression ramp.

8. The apparatus as set forth in claim 4, wherein said face and said outer surface of said rotor intersect at an angle alpha α from about one degree to about fifteen degrees.

9. The apparatus as set forth in claim 1, wherein said gas compression ramps further comprise (a) a throat, and (b) an inwardly sloping gas deceleration ramp.

10. The apparatus as set forth in claim 5, wherein each of said gas compression ramps further comprise a bleed air receiving chamber, and wherein each of said bleed air receiving chambers effectively contains therein, for ejection therefrom, bleed air provided thereto.

11. The apparatus as set forth in claim 1, further comprising an outlet, said outlet configured to receive and pass therethrough high pressure outlet gas after resulting from compression of gas by said one or more gas compression ramps on said rotor.

12. The apparatus as set forth in claim 11, further comprising an inlet casing containing therein a pre-swirl impeller, said pre-swirl impeller located

intermediate said gas inlet and said rotor, said pre-swirl impeller configured for compressing said inlet gas to a pressure intermediate the pressure of said inlet gas and said outlet gas.

13. The apparatus as set forth in claim 12, wherein said pre-swirl impeller is configured to provide a compression ratio of up to about 2:1.

14. The apparatus as set forth in claim 12, wherein said pre-swirl impeller is configured to provide a compression ratio from about 1.3:1 to about 2:1.

15. The apparatus as set forth in claim 12, further comprising, downstream of said pre-swirl impeller and upstream of said one or more gas compression ramps on said rotor, a plurality of inlet guide vanes, said inlet guide vanes imparting spin on gas passing therethrough so as to increase the apparent inflow velocity of gas entering said one or more gas compression ramps.

16. The apparatus as set forth in claim 15, wherein said pre-swirl impeller comprises a centrifugal compressor.

17. The apparatus as set forth in claim 16, wherein said pre-swirl impeller is mounted on a common shaft with said rotor.

18. The apparatus as set forth in claim 15, wherein the apparent velocity of gas entering said one or more gas compression ramps is in excess of Mach 1.

19. The apparatus as set forth in claim 15, wherein the apparent velocity of gas entering said one or more gas compression ramps is in excess of Mach 2.

20. The apparatus as set forth in claim 15, wherein the apparent velocity of gas entering said one or more gas compression ramps is between about Mach 1.5 and Mach 3.5.

21. The apparatus as set forth in claim 12, or in claim 20, wherein said pre-swirl impeller has an outlet for intermediate pressure gas, and wherein said apparatus further comprises a bypass line between said intermediate outlet and said gas inlet, said bypass line configured to route a portion of said gas at said intermediate pressure to said inlet.

22. The apparatus as set forth in claim 21, further comprising a gas flow regulating valve, said valve configured to vary the rate of passage of intermediate gas therethrough, so as to in turn vary the amount of intermediate pressure gas entering said one or more gas compression ramps.

23. The apparatus as set forth in claim 22, where in said valve is adjustable at any preselected flow rate from (a) a closed position, wherein said valves forms a

seal in said bypass line, so that as a result substantially no intermediate pressure gas escapes to said gas inlet, and (b) an open position, wherein said valve allows fluid communication between said pre-swirl impeller outlet and said gas inlet, or (c) a preselectd position between said closed position and said open position.

24. A gas compressor, comprising:

(a) a support structure, said support structure comprising (i) a circumferential housing with an inner side surface, and (ii) a gas inlet for receiving low pressure inlet gas;

(b) a first drive shaft, said first drive shaft rotatably secured along an axis of rotation with respect to said support structure;

(c) a first rotor, said first rotor rotatably affixed with said first output shaft for rotation with respect to said support structure, said first rotor further comprising a first circumferential portion having a first outer surface portion, said first rotor comprising one or more gas compression ramps, each one of said gas compression ramps comprising a portion integrally provided as part of said circumferential portion of said first rotor,

(d) said gas compressor adapted to utilize at least a portion of said inner side surface of said first circumferential housing to compress said inlet gas thereagainst;

(e) one or more strakes on said first rotor, wherein one of said one or more strakes on said first rotor is provided for each of said one or more gas

compression ramps, and wherein each of said one or more strakes on said first rotor extends outward from at least a portion of said circumferential portion of said first rotor to a point adjacent to said inner side surface of said first circumferential housing; and

(f) a first high pressure compressed gas outlet.

25. The apparatus as set forth in claim 24, further comprising:

(a) a second rotor, said second rotor rotatably affixed with said first output shaft for rotation with respect to said support structure, said second rotor further comprising a second circumferential portion having a second outer surface portion, said second rotor comprising one or more gas compression ramps, each one of said gas compression ramps comprising a portion integrally provided as part of said circumferential portion of said second rotor,

(b) said gas compressor adapted to utilize at least a portion of said inner side surface of said second circumferential housing to compress said inlet gas thereagainst;

(c) one or more strakes on said second rotor, wherein one of said one or more strakes on said second rotor is provided for each of said one or more gas compression ramps, and wherein each of said one or more strakes on said second rotor extends outward from at least a portion of said circumferential portion of said second rotor to a point adjacent to said inner side surface of said second circumferential housing; and

(d) a second high pressure compressed gas outlet.

26. The apparatus as set forth in claim 25, wherein said first and second high pressure gas outlets are in fluid communication with a single high pressure gas outlet nozzle.

27. The apparatus as set forth in claim 25, wherein each of said one or more strakes on said first rotor and on said second rotor comprises a helical structure extending substantially radially from said outer surface portion of said first rotor or said second rotor, respectively.

28. The apparatus as set forth in claim 27, wherein the number of said one or more helical strakes on said first rotor or on said second rotor is N, and the number of said one or more supersonic gas compression ramps on said first rotor or on said second rotor is X, and wherein N and X are equal.

29. The apparatus as set forth in claim 25, wherein each of said one or more gas compression ramps comprises a outwardly sloping gas compression ramp face, said face having a base, said base located adjacent the intersection of said outwardly sloping face and said outer surface portion of said first rotor of said second rotor.

30. The apparatus as set forth in claim 29 wherein each of said one or more gas compression ramps further comprise one or more boundary layer bleed ports.

31. The apparatus as set forth in claim 30, wherein at least one of said one or more boundary bleed ports is located at said base of said gas compression ramps.

32. The apparatus as set forth in claim 30, wherein at least one of said one or more boundary bleed ports is located on said face of said gas compression ramp.

33. The apparatus as set forth in claim 25, wherein each of said gas compression ramps further comprise a bleed air receiving chamber, and wherein each of said bleed air receiving chambers effectively contains therein, for ejection therefrom, bleed air provided thereto.

34. The apparatus as set forth in claim 25, further comprising a first inlet casing containing therein a first pre-swirl impeller, said first pre-swirl impeller located intermediate said gas inlet and said first rotor, said first pre-swirl impeller configured for compressing said inlet gas to a pressure intermediate the pressure of said inlet gas and said outlet gas.

35. The apparatus as set forth in claim 34, further comprising a second inlet casing containing therein a second pre-swirl impeller, said second pre-swirl impeller located intermediate said gas inlet and said second rotor, said second

pre-swirl impeller configured for compressing said inlet gas to a pressure intermediate the pressure of said inlet gas and said outlet gas.

36. The apparatus as set forth in claim 35, wherein said first and said second pre-swirl impellers are configured to provide a compression ratio of up to about 2:1.

37. The apparatus as set forth in claim 36, wherein said first and said second pre-swirl impellers are configured to provide a compression ratio from about 1.3:1 to about 2:1.

38. The apparatus as set forth in claim 35, further comprising, downstream of said first and said second pre-swirl impellers and upstream of said one or more gas compression ramps on said first and said second rotors, respectively, a plurality of inlet guide vanes, said inlet guide vanes imparting spin on gas passing therethrough so as to increase the apparent inflow velocity of gas entering said one or more gas compression ramps on said first rotor and on said second rotor.

39. The apparatus as set forth in claim 35, wherein said first and said second pre-swirl impellers each comprise a centrifugal compressor.

40. The apparatus as set forth in claim 35, wherein said first and said second pre-swirl impeller is mounted on a common shaft with said first rotor and with said second rotor.

41. The apparatus as set forth in claim 25, wherein the apparent velocity of gas entering said one or more gas compression ramps is in excess of Mach 1.

42. The apparatus as set forth in claim 25, wherein the apparent velocity of gas entering said one or more gas compression ramps is in excess of Mach 2.

43. The apparatus as set forth in claim 25, wherein the apparent velocity of gas entering said one or more gas compression ramps is between about Mach 1.5 and Mach 3.5.

44. The apparatus as set forth in claim 35, wherein said first pre-swirl impeller has a first intermediate outlet, and wherein said apparatus further comprises a first bypass line between said first intermediate outlet and said first gas inlet, said first bypass line configured to route a portion of said gas at said intermediate pressure to said first inlet.

45. The apparatus as set forth in claim 44, wherein said second pre-swirl impeller has a second intermediate outlet, and wherein said apparatus further comprises a second bypass line between said second intermediate outlet and

said second gas inlet, said second bypass line configured to route a portion of gas at said intermediate pressure to said second inlet.

46. The apparatus as set forth in claim 45, further comprising a first and a second gas flow regulating valve, each one of said first and second valves configured to vary the rate of passage of intermediate gas threrethrough, so as to in turn vary the amount of intermediate pressure gas entering said one or more gas compression ramps on said first rotor and on said second rotor.

47. The apparatus as set forth in claim 46, where in said valves are adjustable at any preselected flow rate from (a) a closed position, wherein said valves form a seal in said first or in said second bypass line respectively, so that as a result substantially no intermediate pressure gas escapes to said first or said second gas inlets, and (b) an open position, wherein said valves allow fluid communication between said first and said second pre-swirl impeller outlets and said first and said second gas inlets, respectively, or (c) a preselected position between said closed position and said open position.

48. The apparatus as set forth in claim 1, or in claim 24, wherein said apparatus is configured to compress a gas selected from the group consisting of (a) air, (b) refrigerant, (c) steam, and (d) hydrocarbons.

49. The apparatus as set forth in claim 1, or in claim 24, wherein said apparatus compresses a selected gas at an isentropic efficiency in excess of ninety (95) percent.

50. The apparatus as set forth in claim 1, or in claim 24, wherein said apparatus compresses a selected gas at an isentropic efficiency in excess of ninety (90) percent.

51. The apparatus as set forth in claim 50, wherein said apparatus operates at a dimensioned specific speed from about 60 to about 120.

52. The apparatus as set forth in claim 51, wherein said apparatus compresses a selected gas at an isentropic efficiency in excess of ninety five percent.

53. The apparatus of claim 1, or claim 24, wherein said rotor comprises a central disc.

54. The apparatus of claim 53, wherein said central disc is tapered, at least in part.

55. The apparatus as set forth in claim 1, or in claim 24, wherein at least a portion of said rotor is confined within a close fitting housing having a minimal

distance D between said rotor and said housing, so as to minimize aerodynamic drag on said rotor.

56. A method of compressing gas, comprising:

(a) providing one or more gas compression ramps on a rotor which is rotatably secured with respect to stationary housing having an inner surface;

(b) supplying to each of said one or more gas compression ramps an inlet gas stream;

(c) compressing said inlet gas stream between said one or more gas compression ramps and said stationary housing, to generate a high pressure gas therefrom;

(d) effectively separating inlet gas from high pressure gas by using one or more strakes along the periphery of said rotor, each of said one or more strakes provided adjacent to one of said or more gas compression ramps, and at least a portion of each of said one or more strakes extending outward from at least a portion of an outer surface portion of said rotor to a point adjacent said inner surface of said stationary housing;

(e) driving said rotor by an input shaft operatively connected to said one or more gas compression ramps.

57. The method as recited in claim 56, wherein the apparent inlet velocity of said one or more gas compression ramps is at least Mach 2.5.

58. The method as recited in claim 56, wherein the inlet velocity of said one or more gas compression ramps is between Mach 2.5 and Mach 4.

59. The method as recited in claim 56, wherein the apparent inlet velocity of said gas compression ramps is approximately Mach 3.5.

60. The method as recited in claim 56, wherein said gas is selected from the group consisting of (a) air, (b) steam, (c) refrigerant, and (d) hydrocarbons.

61. The method as recited in claim 56, wherein said gas is essentially natural gas.

62. The method as recited in claim 56, wherein said gas is air.

63. The method as recited in claim 56, wherein said gas comprises a refrigerant.

64. The method as recited in claim 56, wherein said gas comprises steam.

65. The method as recited in claim 56, further comprising the step of minimizing aerodynamic drag by minimizing the number of leading edge surfaces subjected to stagnation pressure.

66. The method as recited in claim 65, wherein the number of leading edge surfaces subjected to stagnation pressure is less than five.

67. The method as recited in claim 65, wherein the number of leading edge surfaces subjected to stagnation pressure is four.

68. The method as recited in claim 56, wherein each of said one or more gas compression ramps are circumferentially spaced equally apart so as to engage said supplied gas stream substantially free of turbulence from the previous passage through a given circumferential location of any one said one or more gas compression ramps.

69. The method as recited in claim 56, wherein the cross sectional areas of each of the one or more gas compression ramps are sized and shaped to provide a desired compression ratio.

70. The method as set forth in claim 69, wherein the helical strakes are offset at a preselected angle delta, and wherein the angle of offset matches the angle of offset of each one of said one or more gas compression ramps, and wherein said angles match to allow gas entering the one or more gas compression ramps to be at approximately the same angle as the angle of offset, to minimize inlet losses.